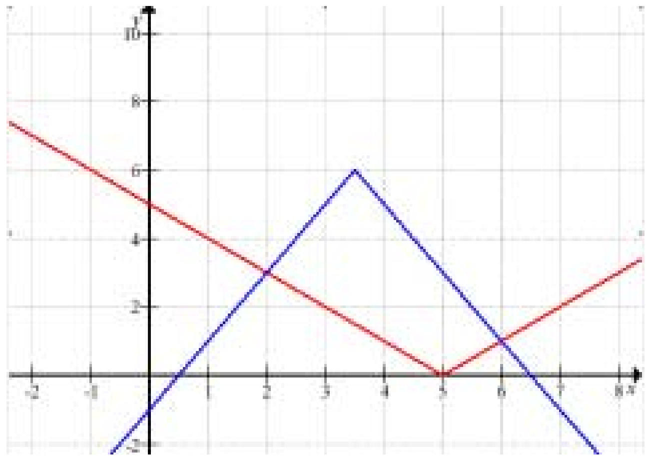
Question	Answer	Marks	Partial Marks
1(a)		4	**M1** for $y = \|x-5\|$: $\vee$ shape with vertex at (5, 0) **A1** Correct graph with *y*-intercept at (0, 5) **M1** for $y = 6 - \|2x-7\|$: $\wedge$ shape with vertex at (3.5, 6) **A1** Correct graph with *y*-intercept at (0, −1)
1(b)	$x < 2$ or $x > 6$ final answer	B2	**B1** for exactly two correct critical values or **B1 FT** for exactly two correct FT critical values soi, FT dependent on at least M1 in **(a)** If the CVs are decimal allow BOD for reasonable values
2	Solves $2x + 2y = 6$ and $2x - \sqrt{3}y = 5$ oe by elimination as far as $2y + \sqrt{3}y = 1$ or substitutes $x = 3 - y$ into $2x - \sqrt{3}y = 5$ oe OR solves $\sqrt{3}x + \sqrt{3}y = 3\sqrt{3}$ and $2x - \sqrt{3}y = 5$ oe by elimination as far as $2x + \sqrt{3}x = 3\sqrt{3} + 5$ or substitutes $y = 3 - x$ into $2x - \sqrt{3}y = 5$ oe	M1	
	$y = \frac{1}{2+\sqrt{3}}$ or $x = \frac{3\sqrt{3}+5}{2+\sqrt{3}}$	A1	
	$y = \frac{1}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$ oe or $x = \frac{3\sqrt{3}+5}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$ oe	M1	**FT** *their* value of *x* or *y* providing of equivalent difficulty
	$y = 2 - \sqrt{3}$ and $x = 1 + \sqrt{3}$	A2	**A1** for either and no extra values
3(a)	$a = 3$	B1	
	$b = 2$	B1	
	$c = -1$	B1	
3(b)(i)	2	B1	

Question	Answer	Marks	Partial Marks
3(b)(ii)	$\frac{2\pi}{3}$ oe or 2.09 or 2.094[395…] rot to 4 or more sf	**B1**	
4(a)	$2x-3=6^{\frac{1}{2}}$ oe, soi	**M1**	
	$x=\frac{6^{\frac{1}{2}}+3}{2}$ or $x=\frac{\sqrt{6}+3}{2}$	**A1**	
4(b)	$\ln\frac{2u}{u-4}=\ln e$ soi or $\ln\frac{2u}{u-4}=1$ soi or $\ln 2u=\ln e(u-4)$ soi	**M1**	Condone one sign or bracketing error
	$\frac{2u}{u-4}=e$ or $2u=e(u-4)$ oe	**M1**	**FT** *their* logarithmic equation
	$u=\frac{4e}{e-2}$ or $u=\frac{-4e}{2-e}$ or equivalent exact form	**A1**	
4(c)	$\frac{3^v}{\left(3^3\right)^{2v-5}}=3^2$ oe soi or $\frac{9^{\frac{v}{2}}}{\left(9^{\frac{3}{2}}\right)^{2v-5}}=9$ oe soi or $\log 3^v-\log 27^{2v-5}=\log 9$ oe soi	**B1**	
	$15-5v=2$ oe or $v\log 3-(2v-5)\log 27=\log 9$	**M1**	**FT** *their* exponential equation in the same base or *their* logarithmic equation with any consistent base, providing *their* exponential or logarithmic equation has at most one sign or arithmetic error
	$v=\frac{13}{5}$ oe	**A1**	

Question	Answer	Marks	Partial Marks
5(a)	$\frac{\sin x}{1-\sin x}+\frac{\sin x}{1+\sin x}$ or $\frac{\operatorname{cosec} x+1+\operatorname{cosec} x-1}{\operatorname{cosec}^2 x-1}$ oe	**M1**	
	$\frac{\sin x+\sin^2 x+\sin x-\sin^2 x}{1-\sin^2 x}$ or $\frac{2\operatorname{cosec} x}{\cot^2 x}$ oe	**A1**	
	$\frac{2\sin x}{\cos^2 x}$ or $\frac{2\sin^2 x}{\sin x\cos^2 x}$ oe	**A1**	
	Fully correct justification of given answer: $\frac{2\sin x}{\cos x}\times\frac{1}{\cos x}=2\tan x\sec x$ or $2\tan x\times\frac{1}{\cos x}=2\tan x\sec x$ or $\frac{2\sin x}{\cos x}\times\sec x=2\tan x\sec x$ or equivalent	**A1**	
5(b)	$2\tan^2 x=5$ or better, soi or $7\cos^2 x=2$ or better, soi or $7\sin^2 x=5$ or better, soi	**B1**	
	$\tan x=[\pm]\sqrt{\frac{5}{2}}$ oe or [±] 1.58[1…] or $\cos x=[\pm]\sqrt{\frac{2}{7}}$ oe or [±] 0.534[5…] or $\sin x=[\pm]\sqrt{\frac{5}{7}}$ oe or [±] 0.845[1…]	**M1**	**FT** an equation of the form $a\tan^2 x=b$ $a>0, b>0$ or $p\sin^2 x=q$ or $p\cos^2 x=q$ where $p>0$, $q>0$ and $p>q$
	57.7 or 57.6884… rot to 2 or more dp 237.7 or 237.6884… rot to 2 or more dp 122.3 or 122.3115… rot to 2 or more dp 302.3 or 302.3115… rot to 2 or more dp	**A2**	no extras in range **A1** for any two correct answers
6(a)	$y=(x-2)^2+4$ oe, isw	**B2**	**B1** for a correct expression in x and y only, that is not of the form $y=f(x)$
6(b)	$\left[\frac{dy}{dx}=\right]2(x-2)$ oe	**B1**	**dep** on **B2** in **(a)**

Question	Answer	Marks	Partial Marks
6(c)	[When $\theta = \frac{\pi}{3}$] $x = 4$ soi	**B1**	
	[When $\theta = \frac{\pi}{3}$] $y = 8$ soi	**B1**	
	[When $x = 4$ or $\theta = \frac{\pi}{3}$] $\frac{dy}{dx} = 4$	**M1**	**FT** *their* $\left.\frac{dy}{dx}\right\|_{x=4}$ providing non-zero
	$y - 8 = 4(x - 4)$ oe isw	**A1**	**FT** *their* $\left.\frac{dy}{dx}\right\|_{x=4}$ providing non-zero
7(a)	**[p** =] $-15\mathbf{i} + 36\mathbf{j}$ isw	**B2**	**B1** for multiplier $\frac{39}{\sqrt{5^2 + 12^2}}$ soi or unit vector $\frac{-5\mathbf{i} + 12\mathbf{j}}{\sqrt{5^2 + 12^2}}$
	[q =] $30\mathbf{i} - 16\mathbf{j}$ isw	**B2**	**B1** for multiplier $\frac{34}{\sqrt{15^2 + 8^2}}$ soi or unit vector $\frac{15\mathbf{i} - 8\mathbf{j}}{\sqrt{15^2 + 8^2}}$ soi
7(b)	[**p** + **q** =] $15\mathbf{i} + 20\mathbf{j}$ or $\begin{pmatrix} 15 \\ 20 \end{pmatrix}$ soi	**B1**	
	$\left[\|\mathbf{p} + \mathbf{q}\| = \sqrt{15^2 + 20^2} = \right] 25$	**B1**	**FT** *their*(**p** + **q**) of the form $\begin{pmatrix} x \\ y \end{pmatrix}$ or $x\mathbf{i} + y\mathbf{j}$ where $x \neq 0$, $y \neq 0$
	53.1[°] or 53.13[01…] rot to 2 or more dp OR 0.927 [rads] or 0.9272[95…] rot to 4 or more sf	**B2**	**M1 FT** *their*(**p** + **q**) of the form $\begin{pmatrix} x \\ y \end{pmatrix}$ or $x\mathbf{i} + y\mathbf{j}$ where $x \neq 0$, $y \neq 0$ <u>and</u> $x \neq y$ for $\tan(...) = \frac{their20}{their15}$ oe or $\cos(...) = \frac{their15}{their25}$ oe or $\sin(...) = \frac{their20}{their25}$ oe

Question	Answer	Marks	Partial Marks
8(a)	$\frac{dy}{dx} = -5(x-1)^{-2} + 2$ oe	B2	**B1** for $\frac{d}{dx}(-5(x-1)^{-1}) = k(x-1)^{-2}$ soi
	$(x-1)^2 = \frac{5}{2}$ or $2x^2 - 4x - 3 = 0$	M1	**dep** on at least **B1**
	$x = 1 + \frac{\sqrt{10}}{2}$ oe, isw or 2.58[11…]	A1	implies **M1**
	$y = 2 + 2\sqrt{10}$ oe, isw or 8.32 to 8.325	A1	
8(b)	[Area of triangle =] 9 soi	B1	
	[Area under curve = F(x) =] $\left[5\ln(x-1) + \frac{2x^2}{2}\right]_2^4$ oe	M2	**M1** for $\int \frac{5}{x-1}\,dx = k\ln(x-1)$ $k \neq 0$ soi or for $5\ln x - 1$
	their 9 + F(4) – F(2)	M1	**dep** on at least **M1**
	21 + 5ln3 isw or 26.49 to 26.5	A1	
9(a)	Attempts to solve $a + 2d = 13$ and $a + 9d = 41$ oe	M2	**M1** for $a + 2d = 13$ and $a + 9d = 41$ soi
	$d = 4$ and $a = 5$	A2	**A1** for $d = 4$ or $a = 5$
9(b)	$\frac{n}{2}\{2(5) + (n-1)4\}$ soi	M1	**FT** *their a* and *their d*
	$2n^2 + 3n - 2555$ [*0]	A1	where * could be = or any inequality sign
	Solves *their* 3-term quadratic of the form $ax^2 + bx + c$ [*0] by factorising or formula or *their* 3-term quadratic of the form $ax^2 + bx * c$ or better if completing the square	M1	
	35	A1	

Question	Answer	Marks	Partial Marks
9(c)	May work ***consistently*** in n throughout but must conclude in k to earn the final mark		
	$S_{2k} = \frac{2k}{2}\{10+(2k-1)4\}$ soi	**B1**	**FT** *their a* and *their d*
	$\frac{2k}{2}\{10+(2k-1)4\} - \frac{k}{2}\{10+(k-1)4\}$ soi	**M1**	**FT** *their a* and *their d* ; condone at most one error
	Simplifies as far as e.g. $8k^2 + 6k - (3k + 2k^2)$ or $8k^2 + 6k - 3k - 2k^2$	**A1**	
	Correct completion to given answer: $6k^2 + 3k = 3k(1 + 2k)$	**A1**	
	Alternative method		
	$\frac{2k}{2}\{2a+(2k-1)d\}$ **and** $a =$ *their* 5 and $d =$ *their* 4 substituted at some point	**(B1)**	
	$ak - \frac{d}{2}k + \frac{3}{2}dk^2$ oe	**(M1)**	condone at most one error
	$5k - \frac{4}{2}k + \frac{3}{2}\times 4\times k^2$	**(A1)**	
	Correct completion to given answer: $6k^2 + 3k = 3k(1 + 2k)$	**(A1)**	
10(a)	$[f'(x) =]\,12x^2 - 8x - 15$	**M2**	**M1** for any two terms correct or $12x^2 - 8x - 15 + c$
	$y = 3$ and $f'(1) = -11$	**A1**	
	$[m_\perp =]\,\frac{1}{11}$ soi	**M1**	**FT** $\frac{-1}{\textit{their}\, f'(1)}$
	$y - 3 = \frac{1}{11}(x-1)$ oe, isw	**A1**	**FT** *their* $m_\perp$ and *their* 3, provided *their* 3 ≠ 1 or 0 or −11

Question	Answer	Marks	Partial Marks
10(b)	[f(–2) =] –32 – 16 + 30 + 18 = 0 or [f(–a) =] $-4a^3 - 4a^2 + 15a + 18$ and shows this to be 0 when $a = 2$ or uses algebraic long division or synthetic division to show that $x + 2$ is a factor of f(x) or that $a - 2$ is a factor of f(–a)	M1	Method must be seen and be fully correct with no clear evidence of calculator use
	$a = 2$	A1	as the only value of a
	Uses ($x + 2$) is a factor to find the correct quadratic factor $4x^2 - 12x + 9$	B2	**B1** for any two out of three terms correct
	Correctly solves *their*($4x^2 - 12x + 9$) ($x + 2$) = 0 or correctly factorises *their*($4x^2 - 12x + 9$) ($x + 2$)	M1	**dep** on using a quadratic factor that has earned at least **B1;** method must be seen; **M0** if *their* quadratic factor does not have real roots
	$x = -2$ or 1.5	A1	**dep** on **M1 B2 M1**